Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 02, pp.45978-45982, February, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

OPTIMIZATION MODEL OF *LENCAM* (*Lethrinus* sp) IN CORAL REEF CONSERVATION IN GURAICI ISLANDS, SOUTH HALMAHERA REGENCY

*Sahlan Norau

Marine Science and Fishery Faculty, Khairun University, Ternate

ARTICLE INFO

Article History:
Received 17th November, 2016
Received in revised form
15th December, 2016
Accepted 20th January, 2017
Published online 28th February, 2017

Key words:
Optimization Model,
Fishing,
Emperor Resource.

ABSTRACT

The prominent economic activity in Guraici Island region is fishing of highly economical coral reef fishes such as grouper, emperor, and others. The main problem emerged if fishing activity is extensive and uncontrolled that will threaten or degrade coral reefs fish resource in the area. The objective of this research was to analyze the fishing optimization model of pink ear emperor (*Lethirinuslentjam,* Lacepede 1802) resource the level of coral reef conservation area changes in Guraici Islands, South Halmahera Regency. This research was conducted in the waters of Guraici Islands from July to September 2015. The methods were experimental fishing and line transect. The results showed that the larger the area of coral reefs in the waters of Guraici Islands, South Halmahera Regency conserved, the lower the fishermen produced. This, however, led to emperor stock being abundant. MEY policy combined with coral reef conservation area protection policy provided more conservative variable indicator but provided positive economic rent compared to the combination of coral reef conservation area protection policy and open access policy.

Citation: Sahlan Norau. 2017. "Optimization model of red ear emperor Fisheryin coral reef conservation Areaguraici islands, south Halmahera regency", *International Journal of Current Research*, 9, (02), 45978-45982.

INTRODUCTION

Coral reefs are homes for thousands of highly economical animals and plants, various sea animals look for food and sheltered themselves in that ecosystem. In maximum condition, coral reefs provide fishes and mollusks up to around 10 – 30 tonnes/km^2 annually (Hanggone *et al.*, 2000). Coral reef fishes is one of fishery resources exploited in a large amount. High utilization rate of coral reef fish resources, especially grouper, pink ear emperor and other coral reef fish is due to international market demands increase steadily from year to year and the selling price of live reef fish for food (LRFF) is relatively high (Sari *et al*., 2007). Change dynamics in a coastal community will directly affect coral reef extraction and also fish population in surrounding area. The change of coral reef cover itself will be mostly determined by the coverage at initial period and direct or indirect exploitation at t+1 period. The connectivity between coral reef cover and fish stock was done through fish stock carrying capacity change which will become a determining variable in fish growth (Fauzi dan Anna, 2005). Major economic activity in Guraici Islands area is fishing of highly economical coral reef fishes like grouper, pink ear emperor, and several other highly economical fishes. Demand of coral reef fishes for food increases steadily, so fishing effort will continue to increase. This condition will threaten coral reef ecosystem.

Corresponding author: Sahlan Norau,
Marine Science and Fishery Faculty, Khairun University, Ternate.

The main problem emerged is when the exploitation of coral reef fishes intensifies and un-controls. This will be hazardous or the coral reef fishes in the area will degrade. Based on that context, it needs a research on optimal management model by analyzing the exploitation of pink ear emperor resource potency against the effect of coral reef cover changes. The objective of this research is to analyze the exploitation model of red ear emperor (*Lethirinuslentjam,* Lacepede 1802) resource at the level of coral reef conservation area change in Guraici Islands, South Halmahera Province. The hypothesis in this research is that the change of coral reef area affects pink ear emperor resource.

METHODS

Research Location and Time

This research was done at the waters of Guraici Islands, South Halmahera Regency, from July to September 2015 (Figure 1). This location selected as data collecting location because this location is one of important coral reef fish fishing grounds in South Halmahera Regency.

Data Source

Data used in this research were primary data consisted of emperor catches using local fishers-owned gill nets operated based on experimental fishing method. Beside that, data regarding coverage area of coral reefs were collected based on transect line method by measuring the distance/area of coral reef cover.

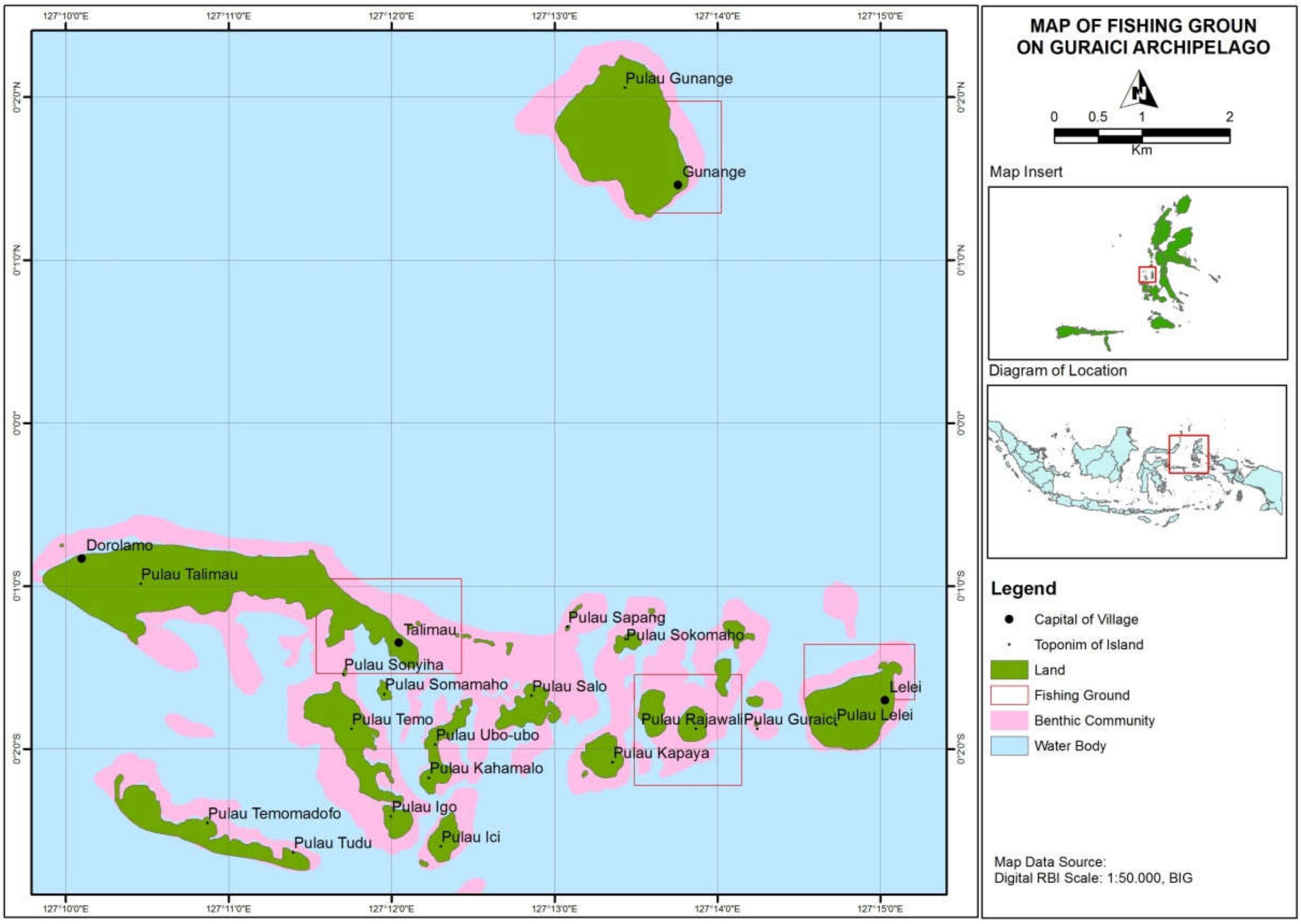

Fig. 1. Research site

Data Analysis

Optimization analysis of coral reef conservation area was done using Gompertz's growth function model (Piegorsch dan Bailer, 2005) with the scenario of coral reef coverage area change at sole owner condition and in the condition of uncontrolled open access. The scenario was analyzed using Maple 11 software. This optimization model of coral reef conservation area was applied in Anna's (2008) research. This optimization scenario model of coral reef conservations was done to find the relationship between pink ear emperor resource and the change of coral reef area. This model was constructed based on an assumption that the entire waters of Guraici Islands is coral reef area that in good condition and by using Gompertz's fish growth function model that was modified for fishery in the coral reef conservation area, as follows; If assumed that biomass growth function of pink ear emperor in the coral reef conservation area follow the Gompertz' function:

$$\frac{dy}{dx} = rxln(K/x) \qquad (1)$$

where: r =intrinsic growth rate of emperor
x =emperor biomass (Kg)
K =environment carrying capacity

while fishing function assumed to follow Cobb-Douglass (1982)

$$h = q\ x\ E \qquad (2)$$

where: h = the production of emperor
q = gill net fishing power
E = effort (trip)

In coral reef conservation area (KKTK), fishing function modified to (Anna, 2008):

$$h = (1-\gamma)q\ x\ E \qquad (3)$$

where: γ = Percentage of KKTK area size

Using equation (3), stock dynamics in equation (1) becomes:

$$\frac{dy}{dx} = rxln(K/x) - (1-\gamma)qxE \qquad (4)$$

Assuming the condition is in equilibrium, the solution of equation (4) produces variable x as a function of biophysical parameter and variable E.

$$x = \frac{K}{-\frac{qE(-1+\gamma)}{\exp r}} (5)$$

Substituting equation (5) into equation (1) produces yield effort equation that contains KKTK parameter as follows:

$$h = \frac{(1-\gamma)qEK}{exp\frac{-(qE(1-\gamma)}{r}} \qquad (6)$$

Meanwhile, economic rent generated from fishing in sustainable condition above is

$$\pi = \frac{p(1-\gamma)qEK}{\frac{-(q(1-\gamma)E}{\exp r}} - cE \quad (7)$$

where: p = fish price
c = fishing cost

To find the optimal effort rate, the economic rent above is derived against effort. The operational derivation of this equation is quite complex to eliminate the exponential. The optimal E value is given by

$$E^* = \frac{\left(Lambert\ W\left(\frac{\exp c}{p(1-\gamma)qK}\right)-1\right)r}{-q(1-\gamma)} \quad (8)$$

Then by substituting E^* into equation (5), optimal biomass value is obtained, i.e.

$$x^* = \frac{c}{p(-1+\gamma)q\ Lambert\ W\left(-\frac{\exp c}{p(-1+\gamma)qK}\right)} \quad (9)$$

Substituting equation (8) into equation (6) gives an equation of optimal production value:

$$h^* = \frac{cr\left(Lambert\ W\left(-\frac{\exp c}{p(-1+\gamma)qK}\right)-1\right)}{p(-1+\gamma)q\ Lambert\ W\left(-\frac{\exp c}{p(-1+\gamma)qK}\right)} \quad (10)$$

This KKTK bioeconomic model was applied on several KKTK size scenarios, relative to total area. Analysis was also performed at condition of management with MEY instrument and without management (open access). In open access condition, in KKTK (the remainder area outside area of open access KKTK) the equilibrium biomass condition is

$$x_\infty^m = \frac{c}{p(1-\gamma)q} \quad (11)$$

The harvest on open access condition in KKTK remainder area is:

$$h_\infty^m = \frac{rc}{p(1-\gamma)q} ln\left(\frac{Kp(1-\gamma)q}{c}\right) \quad (12)$$

Therefore effort at open access condition can be calculated as follows

$$E_\infty^m = r\ ln\left(\frac{Kp(1-\gamma)q}{c}\right) \quad (13)$$

RESULTS AND DISCUSSION

RESULTS

Biology parameter estimation was done using CYP model developed by Clarke, Yoshimoto and Pooley (1992). The estimated parameter in this research includes intrinsic growth rate (r), environment carrying capacity (K), and catchability coefficient (q). Analysis results of r, K, and q values. Natural growth rate (r) of pink ear emperor was 0.98, catchability coefficient (q) was 0.00011, and environment carrying capacity (K) was 721.36 (Table 1). This scenario model of coral reef conservation area (KKTK) was done to predict the amount of red ear emperor catches in Guraici Islands waters. This model was developed with an assumption that the entire waters of Guraici Islands is coral reef area by using fish growth function model by Gompertz that had been modified for fishery in coral reef conservation area.

Table 1. The estimation values of biology parameter using Gomperts function

Parameter	Symbol	Value
Intrinsic growth rate	r	0,98
Catchability coefficient	q	0,00011
Carrying capacity	K	721,36

Scenario analysis of coral reef conservation area in Guraici Islands was done using parameter in Table 1, except for gamma simulation (relative size of coral reef conservation area) for fishing against the size of overall area (KKTK), or that had been determined as shown in Table 2.The condition of no coral reef conservation area (KKTK) or open acces with gamma (γ) equal to zero, production of 153.49 tonnes and efforts of 22461 trips, then the economic rent was zero. On the other hand, at MEY management condition regime with gamma value (γ) of zero, production of 255.12 tonnes and efforts of 7454 trips, then the economic rent was Rp.1,225.05 million. When gamma value (γ) was increased to 0.75 at MEY management regime condition, it gained production value of 201.58 tonnes and efforts of 16,464 trips, then the economic rent was Rp.534.46 million (Tabel 2 and Figure 2).

Table 2. KKTK simulation for pink ear emperor

	Gamma (γ)	Production (ton)	*Effort* (trip)	*Stock* (ton)	*Rente* (Rp.Juta)
	0	255,12	7.455	324,02	1.225,06
MEY	0,15	253,14	8.457	333,43	1.172,09
	0,25	251,2	9.284	341,61	1.126,59
	0,5	241,42	12.198	374,8	948,41
	0,75	201,58	16.464	463,7	534,46
Open Access	0	153,49	22.461,41	64,7	0

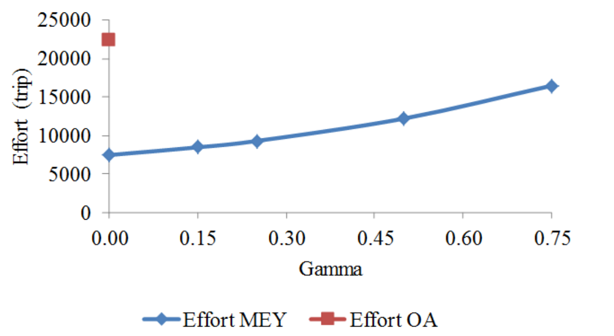

Figure 2. Effort level at several KKTK scenario of MEY regime and at no KKTK (open access)

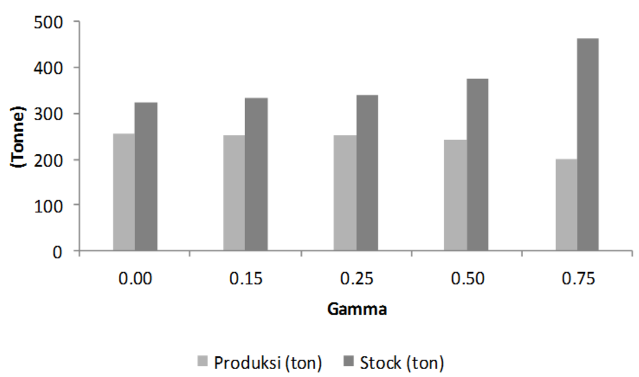

Figure 3. Catch and stock levels at various KKTK scenario of MEY regime

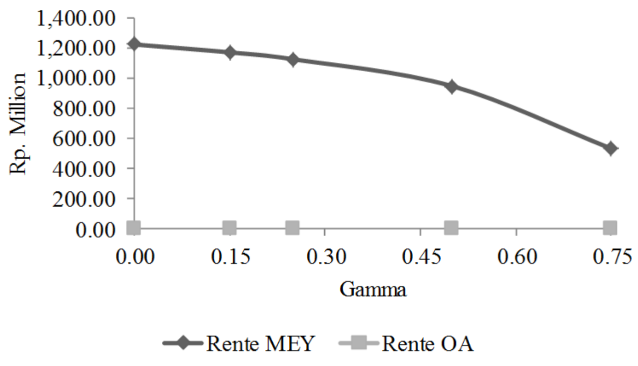

Figure 4. Value of MEY economic rent and open access

Fishing level and sole owner stock or maximum economic yield (MEY) is shown in Figure 3. It can be seen that the higher the gamma value (the larger coral reefs area conserved) was, the lower the production of fishermen was. However, this resulted in an increase in pink ear emperor stock in line of an increase of gamma value or of coral reef area protected. Furthermore, a decrease in economic rent occurred due to limitation of fishing activity in coral reef area which led to a decrease of potential harvest (Figure 4).

DISCUSSION

Based on biological parameter estimation in Table 1, intrinsic (or natural) growth coefficient (*r*) of pink ear emperor resource was 0.98 which means that this resource would grow naturally without a disturbance from the nature or human activity in the rate of 0.98 tonnes per year. Catch ability coefficient was 0.00011 tonnes per trip. This indicated that every one additional effort would increase pink ear emperor catch by 0.00011 tonnes per trip. The coefficient of environment carrying capacity (*K*) was 721.36. This indicated that the environment could support production of pink ear emperor resources of 721.36 tonnes per year in its biological aspect, such as food abundance, population growth, and emperor's body size. Table 2 shows that in the condition without coral reef conservation area (KKTK) or open access (gamma=0) and there were no other controlling instruments or even an established policy on limiting the fishing area, open access for all fishermen, then the emperor fishery in the region would experience an excessive fishing effort up to 16,464 trips per year (Figure 2). The number of effort at MEY regime was smaller because the number of ships fished in this area was limited through permits issued by government. However, in this management regime, the level of effort increased as the area of protected KKTK increased (Figure 2).

This is understandable since the larger the protected area of KKTK is, the more limited or smaller the area for fishing activities is, as a consequence fishermen need higher efforts to catch fish outside the conservation area and it is difficult to have a good amount of catches. Fishing level and stock ownership of sole owner or maximum economic yield (MEY) (Figure 3) showed that the higher the gamma value (the larger the conserved coral reefs area) was, the lower the fishermen's production was. This, however, resulted in an increase in emperor stock size in line with the rise of gamma value or an increase in the size of coral reef closed area. This was consistent with Anna's (2008) statement that MEY sustainable stock would continue to increase with an increase area size that has been protected or restricted against fishing activity like marine conservation area (KKL). The decline of economic rent occurred due to effort that increased steadily resulted from restriction of coral reef area for fishing activity which led to a decrease of potential harvest (Figure 4). Anna (2008) stated that as effort increases, the level of effort efficiency decreases and then lower the net sustainable profit. The restriction of coral reef area due to conservation reasons for fishing activity will impact fishermen revenue because of production decline. However, the protected coral reefs area will be beneficial of increasing biomass and also increasing catches in the future. Furthermore Anna (2008) stated that the implementation of KKL policy will benefit in increasing value and volume of catches, improving catch mix (higher fishing rate for adult fish), but decreasing the variety of caught fish. On the contrary, the drawbacks experienced by fishermen are a decrease in catch, congestion in fishing ground, user conflict, an increase in fishing cost along with the selection of new fishing location, and also an increase of safety risk as the fishing location was getting farther.

The restriction of an area like coral reef conservation for fishing activity will of course give an impact on the declining of fishermen's production or catches. However, if the restriction is well-managed and the controlling is intensive, it will increase primary productivity that useful for the growth and development of aquatic organisms like fish. Besides, the area will give an impact of spill over since the inhabitant fish will migrate out to the unprotected area where fishermen can catch so effort efficiency can be created which then followed by economic rent gains or economic profit. According to Fauzi and Anna (2005), the effect of spill over from an protected areas is that fish stock will grow well and the spill-over of this growth will move out to the area where can be fished sustainably without reducing the source stock in the protected area. Also, marine conservation area has several benefits that are useful for marine resources management in long term.

According to Irnawati *et al*. (2012), fishery management is a series of complex and continuing activities in one fishery system. The success of management is highly depended on the achieved progress at every subsystem as part of it, i.e. fish resources (SDI), effort, and institutions. Coral reef fish management is not separable from the activity of priority commodity development, in addition to the type and number of fishing unit. The management of priority commodity needs to be done optimally since it determines the continuity of fishery management so it is expected that it can boost region economy and reducing disparity among regions. Fishery resources are categorized as natural resources that can be renewed. However, fishing effort with no consideration the resources' ability to recover has resulted in destruction, and even extinction, of fishery resources in several regions (Noija *et al*., 2014). Furhermore Naamin & Harjamulia (1990) stated that even though fishery resources are abundant and renewable, but if there is no controlling effort over the nonstop fishing, it will increase the probability of over fishing to occur in places or fishing ground. To make sure the sustainability of a resource, the exploitation has to be no more than its potency (FAO, 1995). Several previous researches showed that coral reefs area could increase the amount of fishery production if the area was well-managed. Besides, coral reefs area could support other sectors such as marine tourism and educational research. In a study conducted by Sawyer (1992) in Takabonerate coral reefs found that the net present value (NPV) of 500 km^2 coral reefs ecosystem area was Rp.103.43 billion, assuming the amount of catch did not vary with time or fishing intensity.

Furthermore, Cesar (1996) calculated the average value of fishing in Indonesian coral reefs and found that the value of coral reefs fishery (direct use value) was estimated to be US$70.000 per km^2 (Net Present Value, NPV) assuming coral reefs were managed effectively. Economic valuation conducted by GEF/UNDP/IMO (1999) in Malacca Strait, coral reefs of 521,462 ha had direct use value for fishery aspect (US $32,675,099); tourism (US $42,488,099); and research (US $289.55 million per year). While regarding the option value, it reached US $7,781,930. Thus, the total economic value of coral reefs in Malacca Strait (Indonesia) was US $466, 360,403. Furthermore, economic valuation conducted by Putri (2009) produced total economic value of coral reefs in Seribu Islands of Rp.421.71 billion per year and she estimated that potential benefit lost on coral reefs in the area for the next 50 years was Rp.5.16 trillion.

Conclusion

The larger the conserved coral reefs area in Guraici Islands waters, South Halmahera Regency was, the smaller fishers production was. This however resulted in abundant pink ear emperor. MEY policy combined with coral reef conservation area protection policy gave more conservative variable indicator but gave positive economic rent in contrast to combined policy of coral reefs conservation area and open access.

REFERENCES

Anna, S. 2008. Marine Protected Area and Socioeconomi Impacts to the Costal Comunities of Seribu Island. Vietnam. Paper Presented in IIFET Confrence NhaTrang. Juli 21-26.

Cesar, H. 1996. *Economic Analysis on Indonesia Coraf Reefs*. The World Bank, Indonesia.

Cobb, C.W. dan Douglass, P.H. 1982. "*A Theory of Production"*. The American Economic Review 18(1).139-165 hal

FAO. 1995. Code of Conduct for Responsible Fisheries. Food and Agriculture Organization. Rome available at: htttp://www.fao.org/fi/agreem/agreem.asp.

Fauzi dan Anna S. 2005.*Pemodelan Sumber Daya Perikanan dan Kelautan*.Gramedia. Jakarta

GEF/UNDP/IMO. 1999. *Total Economic Valuation: Coastal and Marine resources in the Straits of Malacca.* Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas, Quezon City, PPhilippines.

Hanggono, A., Bambang, K., Suhud, Rasjid A., dan Murad S. 2000. Pemanfaatan Data Satelit Penginderaan Jauh di Indonesia pada Tahun 2000. Seminar Internasional 11 - 12 April 2000. Jakarta.

Irnawati R, Domu S, Budi W, Bambang M, Tri WN. 2012. Model Pengelolaan Perikanan Karang di Taman Nasional Karimunjawa. *Jurnal Forum Pascasarjana* 35 (1); 25-35.

Naamin N dan Harjamulia A. 1990. Potensi, Pemanfaatan dan Penggelolaan Sumber Daya Perikanan, *Prosiding Forum I Perikanan, Balai Peneliti Perikanan Laut*, Jakarta.

Noija D, Sulaeman M, Bambang M, Am Azbas T. 2014. Potensi dan tingkat Pemanfaatan Sumberdaya Ikan Demersal Di Perairan Pulau Ambon-Provinsi Maluku. *Jurnal Perikanan dan Kelautan* 5(1).55-64.

Piegorsch WW. and Bailer AJ. 2005. *Analyzing Environmental Data*, John Wiley & Sons, Ltd, England. 65-68 hal.

Putri I.P. 2009.*Valuasi Ekonomi Terumbu Karang Kawasan Konservasi Laut Kepulauan Seribu* [*Tesis*]. Sekolah Pascasarjana IPB. Bogor. 198 hal.

Sari YD, Tridoyo K, Luky A. 2008. Maximum Economic Yield Sumberdaya Kerapu di Perairan Kepulauan Seribu, DKI Jakarta. *JurnalBijak dan Riset Sosek Kelautan Perikanan* 3 (1).65–74.

Sawyer, D.A. 1992. *Takabonerate: Management, Devolopment, and Resources Valuation of an Indonesia Atoll*. Master Thesis, Dalhausie University, Halifax, N.S, Canada.

****